induction lighting

economical lamps with a long life

It is not widely known that a new type of lamp was introduced in the 1980s: the induction lamp. The design of this lamp, which has no electrodes, ensures that its useful life is not less than 6000–60000 hours*. This means that the lamp, assuming it is on for six hours a day, will last for 3–25 years*. This article gives a brief description of the design.

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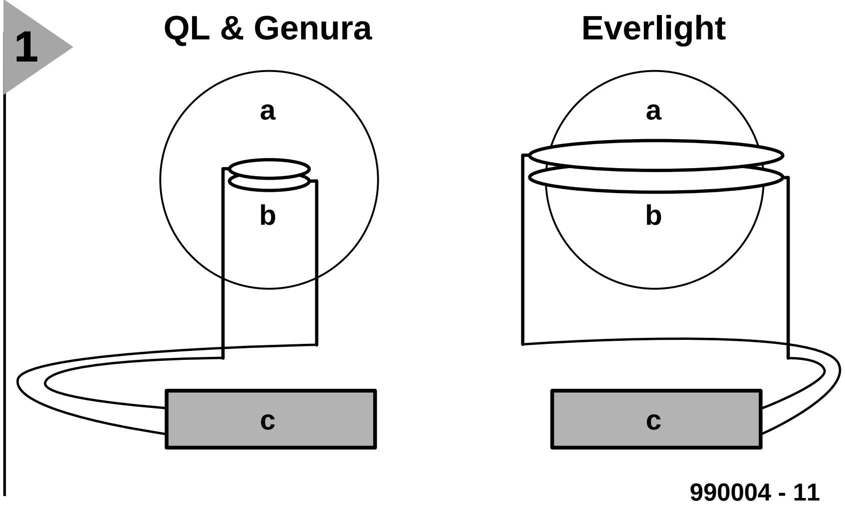

Figure 1. Basic design of an induction lamp. It is built around a discharge tube (a), an inductive-field generator (b), and an r.f. generator (c). There are a number of types on the market, among which the QL, the Genura, and the Everlight.

INTRODUCTION

In spite of it being virtually unknown to the world at large, the induction lamp system has been around since the mid-1980s. In the intervening years, many of its facets have been improved to make it a more practical product and the lamp is consequently now used more and more in industrial applications. No doubt, once it becomes more widely known, many householders will switch to it as well.

The first design, introduced in 1986 by Matshushita Electrical Works in Japan, was originally intended for the home market only. In 1991, Philips of the Netherlands announced a similar lamp, the QL lamp, and a few years later, General Electric launched its R80 Genura Retrofit induction lamp. Today, there are several other types as well, such as the E-lamp from Intersource Technologies, and the Solar 1000 from Fusion Lighting.

The Everlight lamp, the Genura Retrofit lamp, and the E-lamp, are low-power types, whereas the QL lamp is available in 55 W, 85 W, and 165 W ratings. The Solar 1000 lamp, rated at 1400 W, is clearly intended for heavy-duty applications. Nevertheless, all these lamps work on the same principle: an induced discharge in an evacuated tube.

BASIC DESIGN

An induction lamp system consists of three main elements: an evacuated discharge tube or bulb, an induction-field

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* Depending on the type and manufacture of the lamp system.

This article is based on information from Philips Lighting and the article ‘Elektrodenloze lampen’ from International Lighting Review, no. 96/4

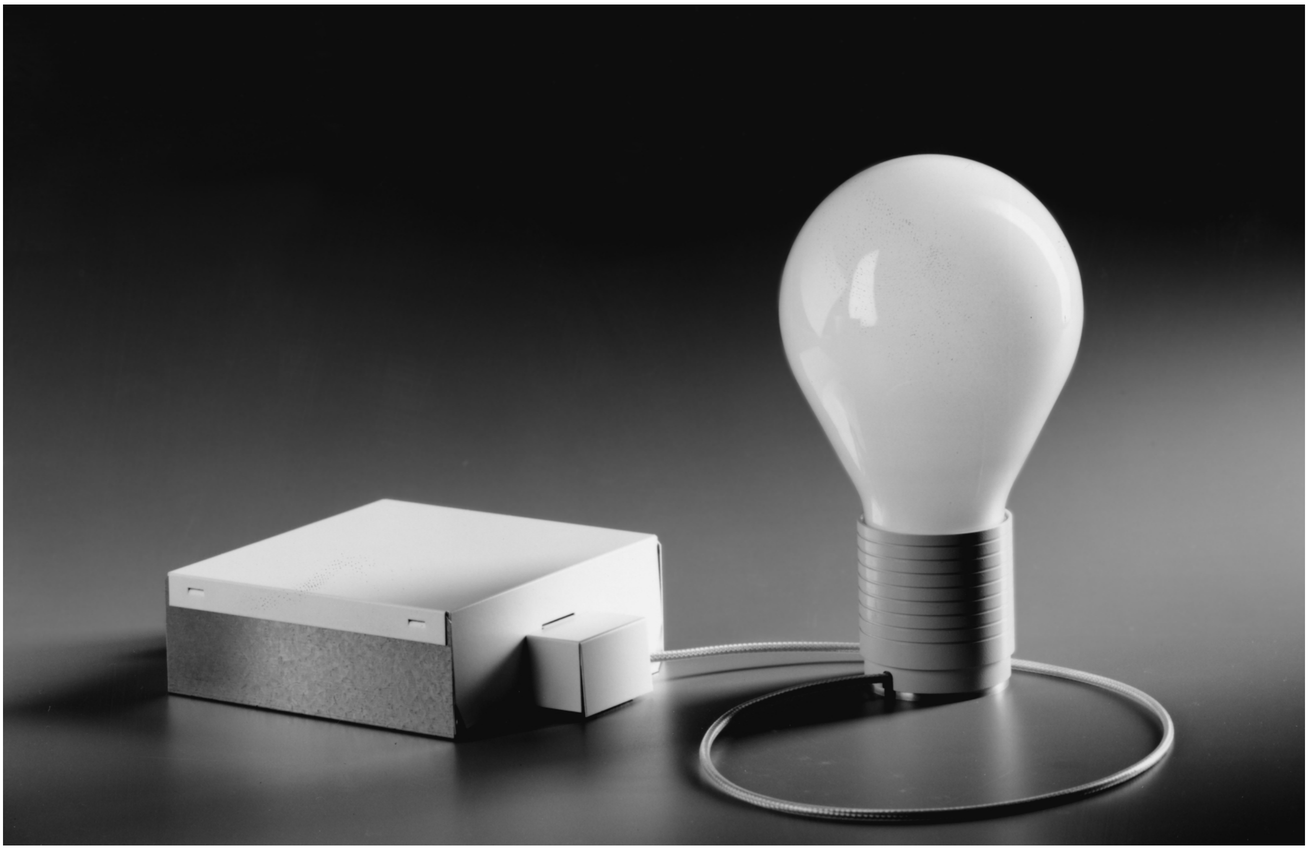

Photo: Philips Lighting

Figure 2. Photo of a practical QL lamp from Philips. The separate r.f. generator is linked to the bulb by a coaxial cable.

generator, and an r.f. generator.

The operating frequency of the r.f. generator is 2.65 MHz in the QL and Genura Retrofit lamps, 13.65 MHz in the Everlight and E-lamps, and 2.45 GHz in the Solar 1000 lamp. The latter system consists of an evacuated discharge tube, a magnetron, a waveguide and a microwave cavity.

The induction-field generator consists of an inductor on a ferrite core. The current flowing through the inductor generates a magnetic field that is magnified by the ferrite core. The magnetic field causes an electric field in the lamp, which generates a circular plasma current around the field generator to sustain the discharge. The system operates like a transformer, in which the inductor is the primary winding and the plasma in the lamp functions as the secondary winding.

The operation is virtually identical to that in a traditional fluorescent tube. The mercury atoms are excited by the discharge and emit ultraviolet photons. These photons are converted into visible light by the phosphor layer at the inside of the tube or bulb.

OPERATION

The basic design of the QL and Genura Retrofit lamps may be understood from the sketch at the left in Figure 1, and that of the Everlight from the sketch at the right. In both sketches the discharge tube is at (a). The electromagnetic field ignites the gas in the tube or bulb, which results in ultraviolet radiation. The current causing the electromagnetic field flows through the inductive-field generator (b). The r.f. generator at (c) is the electronic system that generates the r.f. signals that are converted into an electric field by the field generator. This is the circuit that in practice appears to determine the ultimate life of the lamp.

Figure 2 shows a practical QL lamp, although in normal use this is usually mounted in a suitable holder.

In the field generator in **Figure 3a**, the alternating current, I_p, in the primary coil induces a corresponding current at the same frequency, I_s, in the secondary coil. In the QL lamp system, the secondary coil is formed by the metal evaporated in the bulb.

In **Figure 3b**, the free electrons in the metal vapour are excited by the induced secondary current, which results in ultraviolet radiation. This radiation is converted into visible light by the phosphor layer on the inside of the bulb.(1: gas vapour atom; 2: visible light; 3: fluorescent powder).

Figure 3c shows the discharge tube of the QL lamp system in the shape of a sealed glass bulb that is filled with a noble gas at low pressure and a small quantity of vapourized mercury. (1: cavity; 2: fluorescent coating; 3: residual amalgam; 4: main amalgam; 5: lamp socket).

The external r.f. generator in **Figure 3d** generates an alternating current at a frequency of 2.65 MHz for the primary coil of the field generator in Figure 3a. (1: primary coil; 2: 40 cm coaxial cable; 3: 2.65 MHz oscillator; 4: mains voltage terminals; 5: pre-treatment; 6:filter; 7: r.f. generator.

LONG LIFE

Because the discharge tube has no electrodes, the life of the system is determined primarily by the associated electronics. The estimated average life quoted by manufacturers, that is, the time after which 50 per cent of the lamps still function correctly, is 10 000 hours for the Genura lamp; 15 000 hours for the Solar 1000 system; 50 000 hours for the E-lamp, and 100 000 hours for the QL lamp. Consumers, however, are more interested in the practical life span, that is, the period after which 80 per cent of the lamps is still in working order but the light emission has been reduced to 70 per cent. Generally, this is about 60 per cent of the estimated average life, that is, in the case of a QL lamp, about 60 000 hours.

INTERESTING FACTS

The shape of most induction lamps is similar to that of traditional incandescent lamps. This means that the light flux of these new lamps can be controlled much more effectively by reflectors than that of standard fluorescent lights.

As mentioned before, induction lamps are electronic products that gen-

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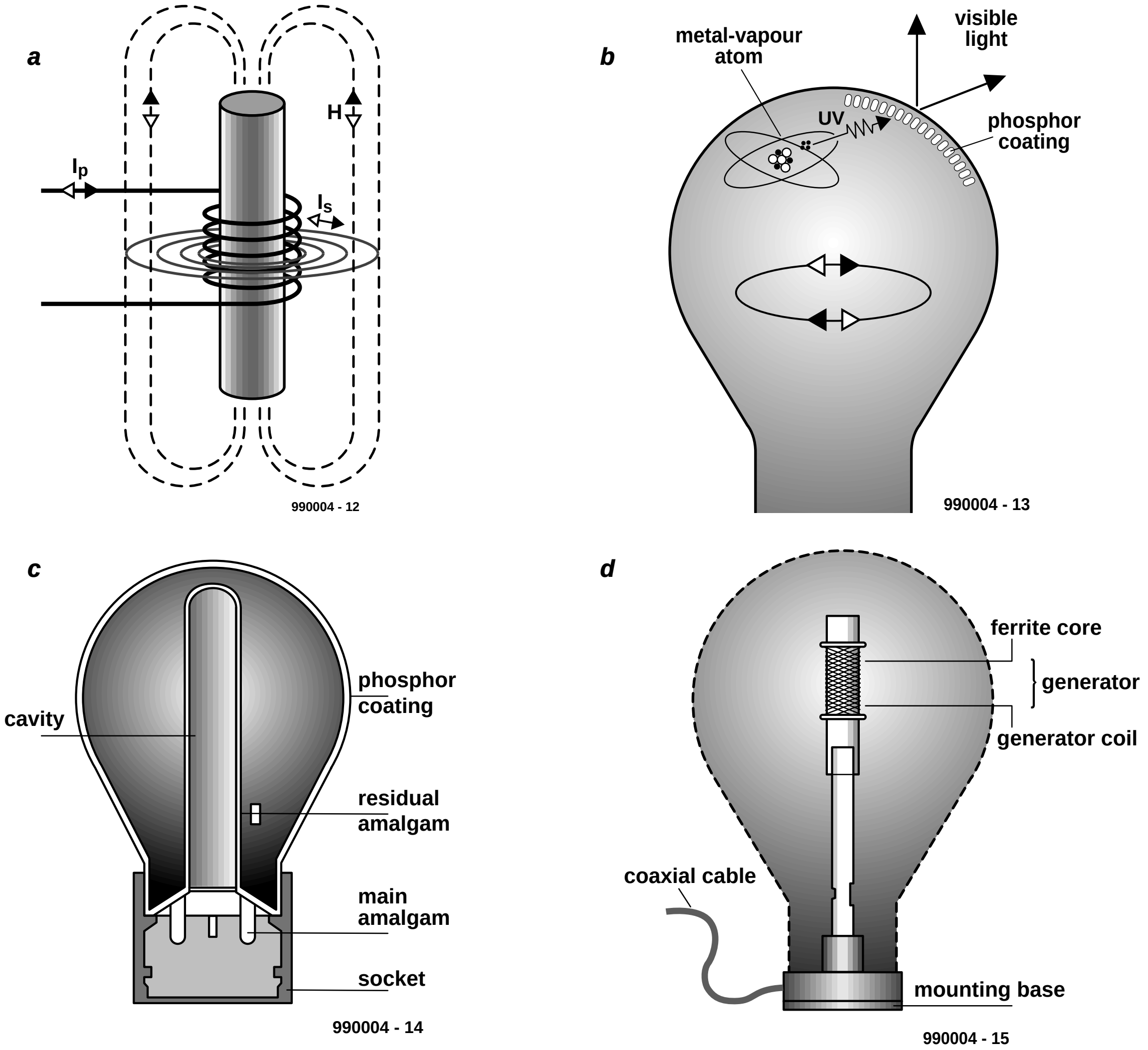

Figure 3. Four sketches to illustrate the operation of an induction lamp.

erate electromagnetic radiation. If these waves interfere with other signals, electromagnetic interference (EMI) may ensue. At present, there are few guidelines for interference suppression in the case of lamps rated at up to 25 watts. Until recently, higher power QL lamps used an effective but expensive holder to meet current radiation requirements.

A general complaint regarding induction lamps is that they are not available in higher powers. The Solar 1000 System, which is rated at 1400 watts, proves that the light flux is not a limiting factor.

The length of standard fluorescent tubes increases in direct proportion to the power rating. Because induction lamps are also fluorescent products, their light-emitting surface will also increase with the power rating. However, since induction lamps are normally bulb-shaped, their surface area will increase with with only the fourth root of the power.

Although none of the currently available induction lamps is suitable for use with a dimmer switch, this does not mean that the light produced by these lamps cannot be dimmed. Since the relevant electronics is integrated in the lamp system, it should be possible to implement dimmers in it.

NEW VARIANTS

The electromagnetic interference (EMI) has been reduced drastically in the latest generation of QL lamps. Provided they are properly earthed, these lighting systems meet the requirements of EN5501, EN55022, and FCC Part 15 Class B. This means that designers of suitable holders for these lamps need not worry about possible design limitations.

Also, the r.f. generator for use with the latest variants is about 30 per cent smaller than the previous generation. This means that the QL lamp can be integrated more readily in holders.

QL lamps are now available with powers up to 165 watts. A discharge tube only 13 cm (5 in) long can produce a luminous flux of 12 000 lm.

General Electrics has recently introduced a smaller version of its Genura lamp. Rated at 15 watts, this lamp produces a luminous flux of 700 lm.

The Endura system from Osram is rated at 150 watts and operates with (the relatively low) frequency of 250 kHz. It produces a luminous flux of about 80 lm/watt, that is, 12 000 lm.

CONCLUSION

The new generation of induction lamps combines the advantages of fluorescent lighting, such as low energy consumption, low heat production, variable colour (within reason), high efficiency, and long life, with the advantages of the incandescent lamp. Especially attractive is the round shape, which makes it much easier (and cheaper) to produce holders (sockets) than for the long neon tubes, and to replace standard incandescent lamps.

Owing to their current high price, induction lamps are at present used only in situations where the replacement of lamps is expensive: rooms with high ceilings, tunnels, theatres, street lights, and so on. The high initial investment is largely compensated by the very low maintenance costs.

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